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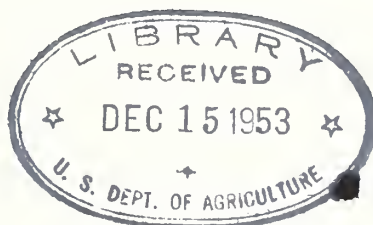
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UNITED STATES DEPARTMENT OF AGRICULTURE  
Production and Marketing Administration  
Cotton Branch

EFFECT OF ATMOSPHERIC CONDITIONS ON TESTING  
CERTAIN COTTON FIBER PROPERTIES



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Washington, D. C.  
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The study reported in this publication was planned and conducted under the administrative direction of John W. Wright, Chief, Research and Testing Division, Cotton Branch of the Production and Marketing Administration. Acknowledgment is made to the members of the testing laboratory at Washington, D. C., for conducting the tests essential to this study.

## SUMMARY AND CONCLUSIONS

Controlled atmospheric conditions, within narrow specified tolerances, for the testing of cotton fibers are essential in order to obtain comparable and reproducible test results because such results are affected by the atmospheric conditions under which testing is performed.

Results from the study on which this report is based indicate that an increase in relative humidity has the following effects on cotton fiber testing when the temperature is held constant at 70° F.:

1. Fiber fineness by the Micronaire instrument:

An increase in relative humidity results in an increase of the Micronaire value. The coarser cottons are affected more than the finer cottons for the same change in relative humidity. The increase in Micronaire value averaged 0.05 microgram per inch for each 10-percent increase in relative humidity.

2. Fiber strength by the Pressley instrument:

An increase in relative humidity results in an increase in the strength of cotton fibers with the stronger cottons showing the greatest increase. On an average for the five cottons tested, the results indicated that an increase of 1 percent in relative humidity will bring about an increase in tensile strength of approximately 150 pounds per square inch.

3. Fiber length and length uniformity by the Fibrograph instrument:

An increase in relative humidity results in an increase of Fibrograph length and length uniformity results. The longer cottons tend to be affected more than the shorter cottons for the same increase in relative humidity. On an average for the five cottons tested, the results indicated that an increase of 1 percent in relative humidity will bring about an increase of approximately 0.002 inch in upper half mean length and an increase of approximately 0.1 in the uniformity index unit.

The results also indicated that an increase in temperature has the following effects on cotton fiber testing when the relative humidity is held constant at 65 percent:

1. Fiber fineness by the Micronaire instrument:

An increase in temperature results in a decrease of the Micronaire readings in the range of 60° to 70° F. and in a slight increase in the range from 70° to 90° F. The greatest effect was noted between 60° and 65° F.

2. Fiber strength of the pressley instrument:

An increase in temperature results in an increase in the strength of cotton fibers with the stronger cottons showing the greater effect. The greatest change was noted between 70° and 75° F.

3. Fiber length and length uniformity by the Fibrograph instrument:

An increase in temperature results in a slight increase in the Fibrograph results, with the greatest change being noted between 70° and 75° F.

Correction factors cannot be used satisfactorily to adjust Pressley strength and Fibrograph length test results to standard conditions when such tests are made at some other atmospheric conditions. In the case of the Micronaire fineness tests, however, correction factors may be used in certain cases for adjusting the Micronaire readings obtained at other than standard conditions to those normal at standard conditions.

# EFFECT OF ATMOSPHERIC CONDITIONS ON TESTING CERTAIN COTTON FIBER PROPERTIES

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## INTRODUCTION

Controlled atmospheric conditions in the testing of cotton fibers are becoming more important as more and more cotton is being merchandised on the results obtained from cotton fiber testing. This can be fully appreciated when it is realized that comparability and reproducibility of the results of such testing depend partly on standard atmospheric conditions. Variation in cotton fiber test results may be so great, when provision has not been made for controlled atmospheric conditions within narrow prescribed tolerances, that a cotton may be rejected as being below specifications under one set of conditions but might be acceptable under another set of conditions, or vice versa. Inasmuch as uncontrolled atmospheric conditions may vary widely from day to day and from place to place, the effect of atmospheric conditions on the results of cotton fiber testing is an important item from the standpoint of making decisions with respect to breeding and merchandising of cotton.

This study consisted of two separate phases, namely:

- (1) The relative humidity phase to ascertain the effect of relative humidity at a constant temperature on the testing of cotton fibers; and
- (2) The temperature phase, to ascertain the effect of temperature at a constant relative humidity on the testing of cotton fibers.

Both phases of the study were conducted at the Washington laboratory where special facilities have been provided for varying humidity and temperature over a wide range.

## EXPERIMENTAL PROCEDURE

Five varieties of cotton, from the supply of check test material, representing a range of fiber properties were selected for this study. The experimental procedure included the testing of five replicate samples from each of the five varieties of cotton. All test samples were conditioned overnight before being tested at the prescribed atmospheric condition. All conditioning was done from the dry side with the exception of the 28-percent relative humidity condition.

Samples weighing 7 grams were extracted for each of the five replications from each of the five cottons for the test. Each sample was blended and tested for fiber fineness by the Micronaire instrument, for

fiber length by the Fibrograph instrument, and for fiber strength by the Pressley instrument in accordance with standard laboratory procedure. The experimental procedure included tests by two technicians for length and strength and tests by one technician for fineness. All testing was done by the same technicians at all conditions for each phase of the study.

Daily operator check tests were performed at standard atmospheric conditions before testing the samples at prescribed atmospheric conditions. Two air-conditioned laboratory rooms were used concurrently, one controlled at standard atmospheric conditions for daily operator check tests and the other for the prescribed atmospheric condition tests.

Seven conditions of relative humidity, ranging from 28 to 85 percent at 70° F. temperature, and seven conditions of temperature, ranging from 60° to 90° F. at 65 percent relative humidity, were employed in the two phases of the study (table 1). In the humidity phase of the study, a condition of 25-percent relative humidity was scheduled but this condition could not be obtained because of unusually high outside temperatures and humidities. Therefore, the 28-percent condition was substituted. The humidity phase of the study was scheduled in order of ascending relative humidity and the temperature phase was scheduled in order of ascending temperature.

Duplicate moisture tests were made on each of the five cottons, at each relative humidity change. One moisture sample was taken just before tests were begun and the second sample was taken after tests were completed. As a further check on the moisture effect, a 100-grain sample was weighed from each of the five cottons at standard conditions. These samples were allowed to remain exposed to the atmosphere, and they were weighed each time moisture samples were taken. The two weighings for each condition were averaged to obtain a weight for each condition.

Moisture tests were not made for the temperature phase because a previous study by Rouse and Burns <sup>1/</sup> indicated that temperature has little effect on moisture content. The results of the moisture tests indicated that good control and adequate conditioning were obtained in this study (table 2).

In order to check the reliability of the humidity conditions actually obtained, an electric humidity indicator was located within the conditioning rooms where the tests were being performed. Numerous observations of the indicator during the tests showed that the range of relative humidity at any one condition did not exceed 2 percent. The temperature was checked by a dry bulb thermometer, and in no case did the range in temperature exceed 1° F. for any prescribed condition.

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<sup>1/</sup> "Effect of Atmospheric Conditions on Processing and Testing of Carded Cotton Yarn." By Joseph T. Rouse and William H. Burns. Cotton Branch, Research and Testing Division, U. S. Dept. of Agriculture.

Table 1.--Combinations of atmospheric conditions employed in the testing of cotton fibers for five selected cottons in the two phases of the study

Humidity phase			:	Temperature phase		
Temperature <u>1/</u>	Relative humidity <u>1/</u>		:	Temperature <u>1/</u>	Relative humidity <u>1/</u>	
<u>°F.</u>	:	<u>Percent</u>	:	<u>°F.</u>	:	<u>Percent</u>
70	:	28	:	60	:	65
70	:	35	:	65	:	65
70	:	45	:	<u>70</u>	:	<u>65</u>
70	:	55	:	75	:	65
<u>70</u>	:	<u>65</u>	:	80	:	65
70	:	75	:	85	:	65
70	:	85	:	90	:	65

1/ Underlined numbers represent standard laboratory conditions.

## DISCUSSION OF RESULTS

### Relative Humidity Phase of the Study

#### Fiber Fineness by the Micronaire Instrument

The average Micronaire value obtained for the five selected cottons ranged from 4.38 to 4.69 micrograms-per-inch when the testing room relative humidity was increased from 28 to 85 percent at 70° F. temperature (fig. 1). It is interesting to note that the increase in micrograms-per-inch for each cotton had approximately the same trend for the same increase in relative humidity; however, the rate of increase in micrograms-per-inch was not proportional to an increase in relative humidity (table 3). In other words, the effect of relative humidity on micrograms-per-inch values obtained on the Micronaire was not a straight line relationship. There was a tendency for the coarser cottons to be affected more than were the finer cottons. It is believed that this trend would have been more pronounced if the test had included cottons with a much wider range of Micronaire values. However, the cottons included in the study were considered typical of the average range of cottons produced throughout the American Cotton Belt.

Table 2.--Effects of various atmospheric conditions on moisture content of cotton and weight of samples in the two phases of the study

Relative humidity phase			Temperature phase		
Relative humidity <u>1/</u>	Moisture content <u>1/</u>	Av. wt. of sample <u>1/</u>	Temperature <u>1/</u>	Av. wt. of sample <u>1/</u>	
Percent	Percent	Grains	OF.	Grains	
28	3.78	96.5	60	99.3	
35	3.76	96.9	65	99.3	
45	4.61	97.8	<u>70</u>	<u>100.0</u>	
55	5.48	98.6	75	99.9	
<u>65</u>	<u>6.03</u>	<u>100.0</u>	80	99.7	
75	7.98	102.0	85	100.0	
85	8.54	104.4	90	99.8	

1/ Underlined numbers represent standard laboratory conditions.

#### Fiber Strength by the Pressley Instrument

The average tensile strength values obtained for the five selected cottons ranged from 81,020 to 89,020 pounds per square inch when the testing room relative humidity was increased from 28 to 85 percent at 70° F. temperature (figure 2). The results for each of the five cottons indicated that strength values increase with an increase in relative humidity (table 4). However, the amount of strength increase varies with the particular cotton being tested. The Lockett cotton increased 6,400 pounds per square inch, when tested under the extreme range of relative humidity, and the Pima cotton increased 12,200 pounds per square inch. On an average for the five cottons tested, the results indicated that an increase of 1 percent in relative humidity will bring about an increase in tensile strength of 150 pounds-per-square-inch. In the case of the Lockett cotton, an increase of 1 percent in relative humidity effected an increase of 75 pounds-per-square-inch and for the Pima cotton an increase of 300 pounds-per-square-inch.

#### Fiber Length and Length Uniformity by Fibrograph Instrument

The average Fibrograph upper half mean lengths for the five selected cottons ranged from 1.086 to 1.178 inches when the testing room relative humidity was increased from 28 to 85 percent at 70° F. temperature

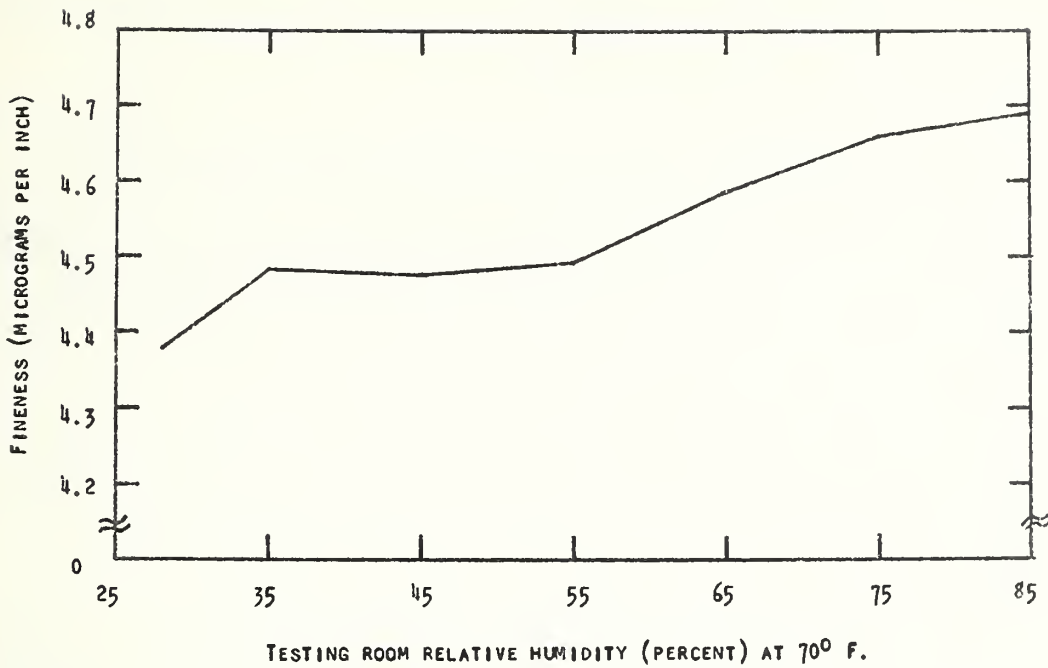


Figure 1.--Average micronaire fineness values for five cottons tested at specified relative humidities.

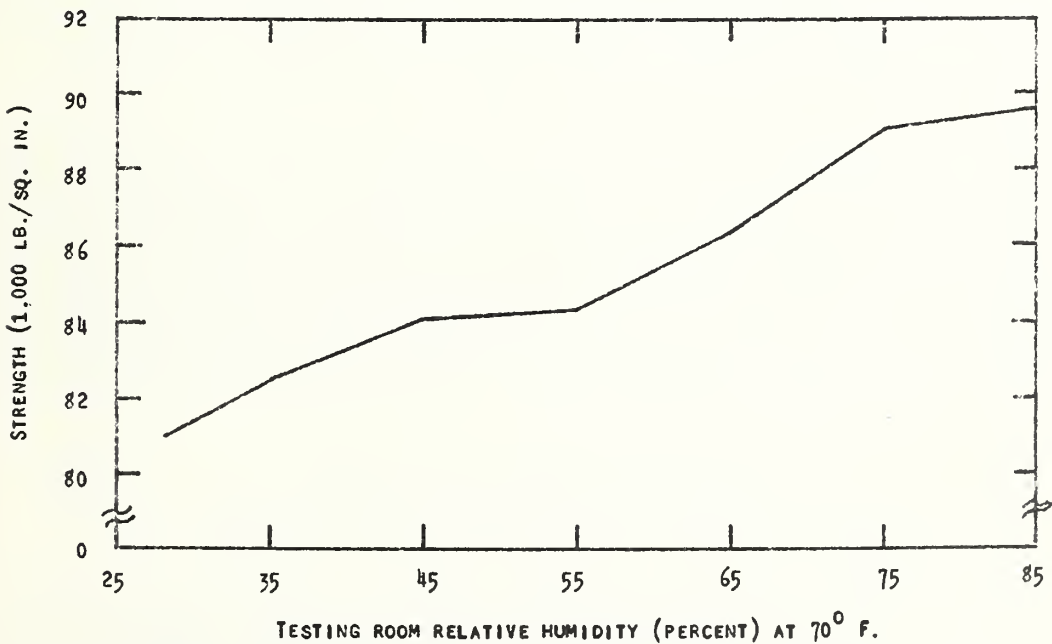


Figure 2.--Average Pressley strength for five cottons tested at specified relative humidities.

Table 3.--Fiber fineness by Micronaire for five cottons when tested under specified relative humidities at 70° F. temperature

Relative humidity 2/	Fineness (weight-per-inch) for specified cotton 1/					
	Lockett 2/	Rowden 2/	Delta-pine 2/	Mesilla valley 2/	Pima 2/	Average 2/
Percent	Micrograms per inch	Micrograms per inch	Micrograms per inch	Micrograms per inch	Micrograms per inch	Micrograms per inch
28	5.48	5.39	4.53	3.81	2.69	4.380
35	5.51	5.43	4.68	3.90	2.90	4.484
45	5.49	5.51	4.61	3.92	2.85	4.476
55	5.59	5.53	4.63	3.87	2.84	4.492
<u>65</u>	<u>5.69</u>	<u>5.63</u>	<u>4.74</u>	<u>3.98</u>	<u>2.90</u>	<u>4.588</u>
75	5.83	5.68	4.81	4.04	2.94	4.660
85	5.82	5.73	4.81	4.10	2.99	4.690

1/ Each value represents the average of five complete tests as determined by the Micronaire instrument.

2/ Underlined numbers represent standard laboratory conditions.

(fig. 3). Length uniformity index varied from 78.4 to 84.2 (fig. 4). The results for each of the five cottons indicated that the length increase is approximately proportional to an increase in relative humidity; however, the magnitude of the increase varies with each cotton (table 5). On an average for the five cottons tested, the results indicated that an increase of 1 percent in relative humidity will bring about an increase of approximately 0.002 inch in the upper half mean length and an increase of approximately 0.1 in the uniformity index unit.

#### Temperature Phase of the Study

##### Fiber Fineness by the Micronaire Instrument

The average Micronaire readings obtained on five selected cottons showed a decrease in fineness values when the testing room temperature was increased at 5° intervals from 60° to 70° F. and a slight increase as the temperature was increased from 70° to 90° F., the relative humidity being held constant at 65 percent (fig. 5). Each of the five cottons showed similar trends, with the greatest effect being noted between 60° and 65° F. (table 6).

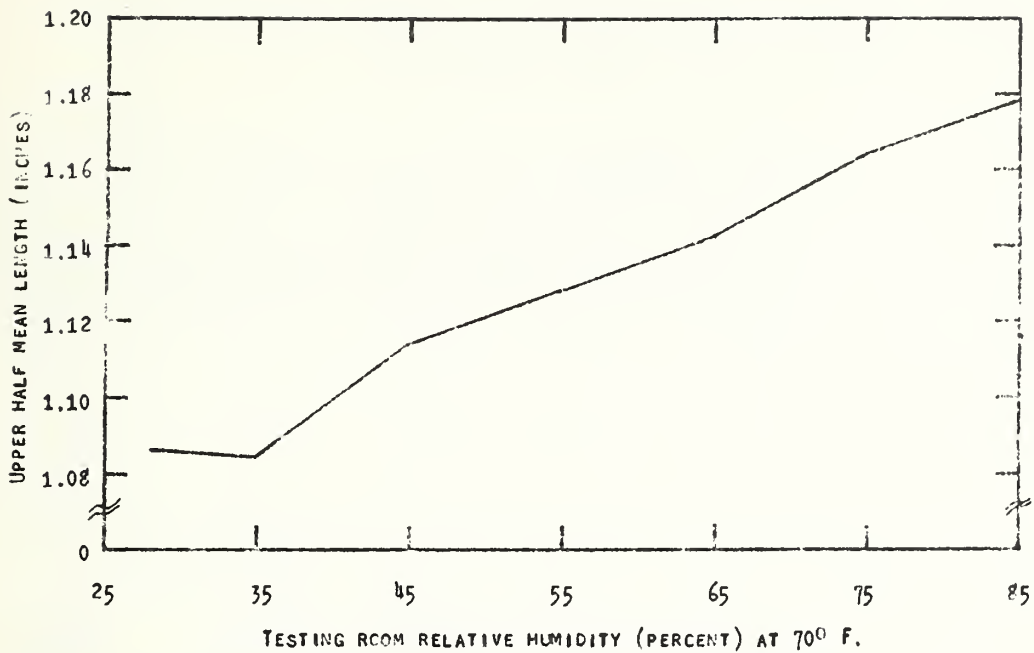


Figure 3.--Average fibrograph upper half mean length for five cottons tested at specified relative humidities.

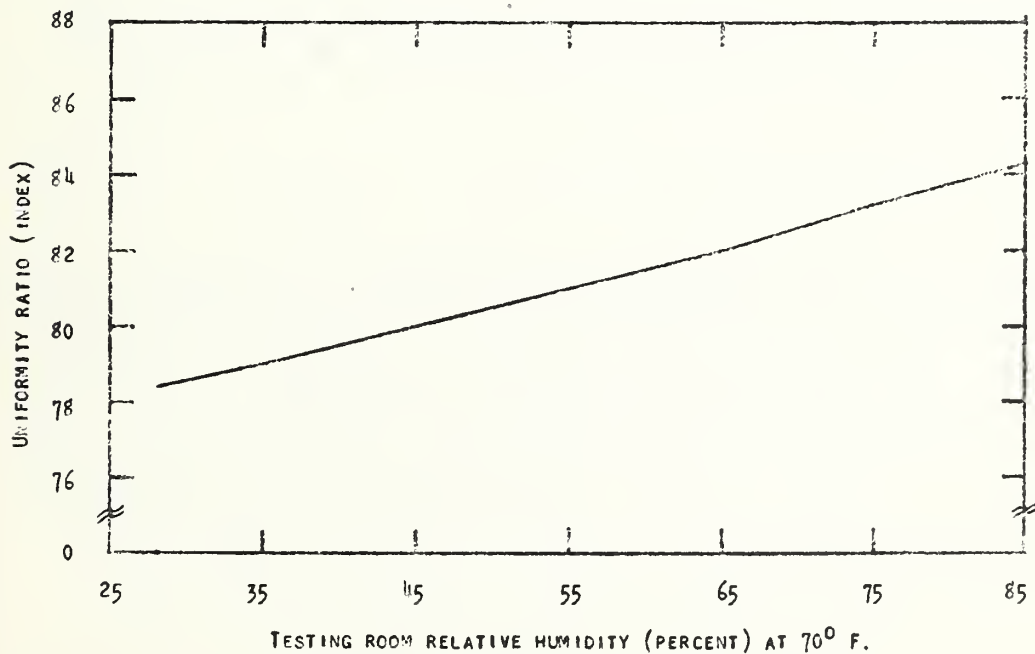


Figure 4.--Average fibrograph uniformity ratio for five cottons tested at specified relative humidities.

Table 4.--Fiber strength for five cottons when tested under specified relative humidities at 70° F. temperature

Relative humidity 2/	Fiber strength for specified cotton 1/					
	Lockett 2/	Rowden 2/	Delta-pine 2/	Mesilla valley 2/	Pima 2/	Average 2/
Percent	1,000 lb./sq. in.	1,000 lb./sq. in.	1,000 lb./sq. in.	1,000 lb./sq. in.	1,000 lb./sq. in.	1,000 lb./sq. in.
20	73.0	79.0	73.6	82.9	96.6	81.02
35	74.5	80.8	74.8	85.6	97.2	82.58
45	75.4	80.4	75.5	87.3	101.9	84.10
55	74.6	81.6	77.2	87.2	101.4	84.40
<u>65</u>	<u>75.4</u>	<u>83.6</u>	<u>79.0</u>	<u>89.6</u>	<u>104.4</u>	<u>86.40</u>
75	78.8	86.2	81.4	91.6	107.3	89.06
85	79.4	87.2	80.7	92.0	108.8	89.62

1/ Each value represents the average of five complete tests as determined by the Pressley fiber strength instrument.

2/ Underlined numbers represent standard laboratory conditions.

#### Fiber Strength by the Pressley Instrument

The average tensile strength values obtained for the five selected cottons ranged from 85,320 to 88,980 pounds-per-square-inch, when the testing room temperature was increased from 60° to 90° F. at 65 percent relative humidity (fig. 6). The results for each of the five cottons indicated that the strength values increase with an increase in temperature. However, the amount of strength increase varies with the particular cotton being tested. The stronger cottons showed a greater increase for a given increase in temperature than did the weaker cottons. The greatest increase occurred when the temperature was changed from 70° to 75° F. (table 7). This was also true for the Fibrograph tests.

#### Fiber Length and Length Uniformity by the Fibrograph Instrument

The average Fibrograph upper half mean length and length uniformity ratio values showed a range of 0.025 inch and 1 index unit, respectively, when the testing room temperature was increased from 60° to 90° F. (5° intervals) at 65 percent relative humidity (figs. 7 and 8). The greatest

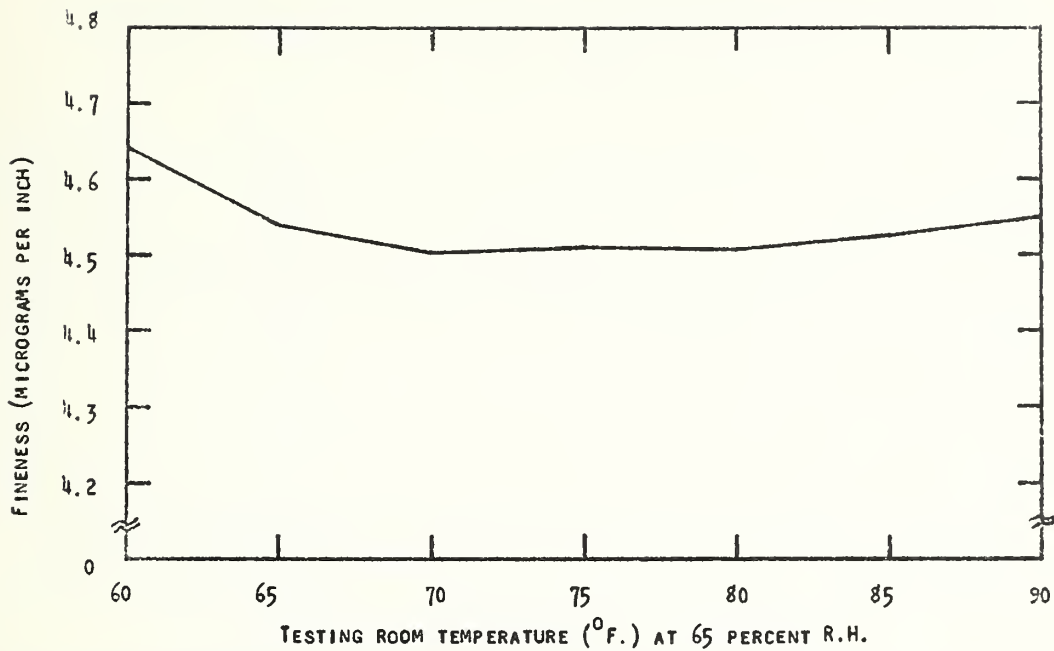


Figure 5.--Average micronaire fineness values for five cottons when tested at specified temperatures.

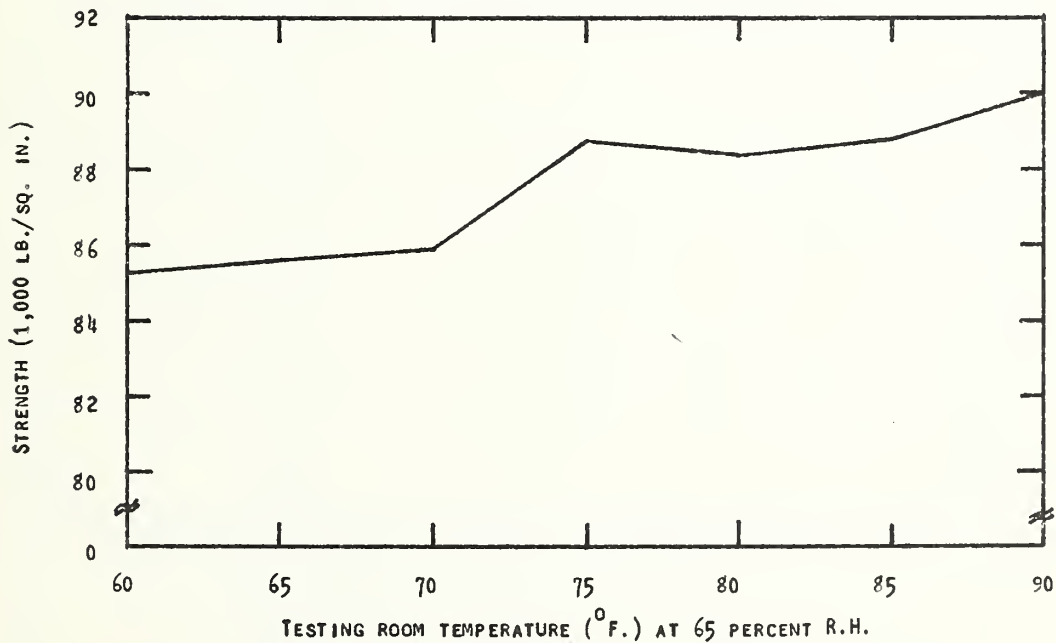


Figure 6.--Average Pressley strength for 5 cottons when tested at specified temperatures.

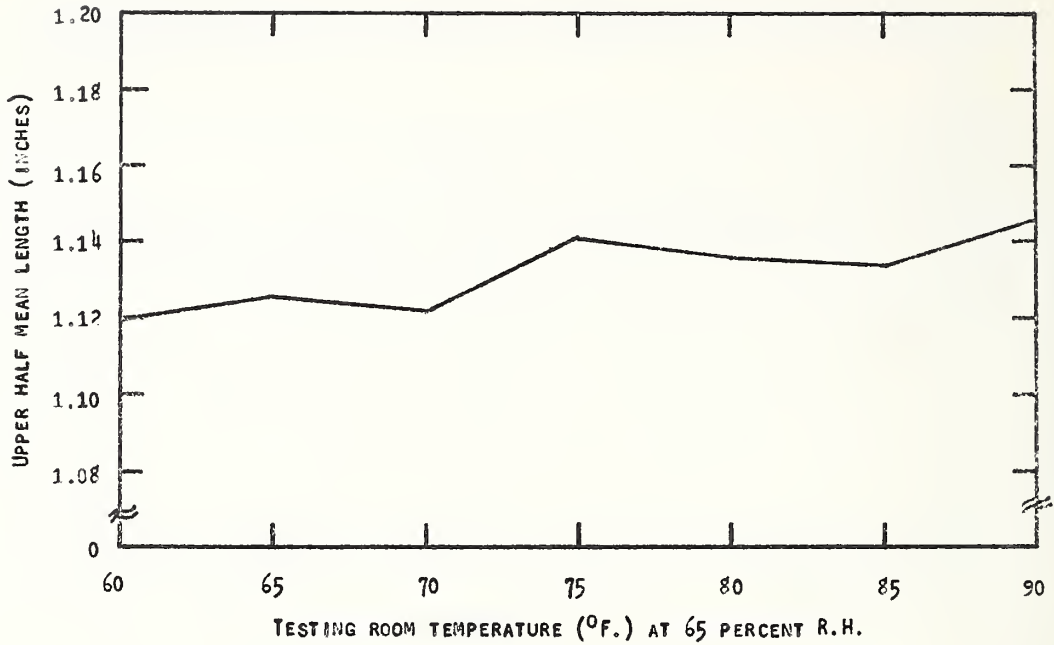


Figure 7.--Average fibrograph upper half mean length for five cottons when tested at specified temperatures.

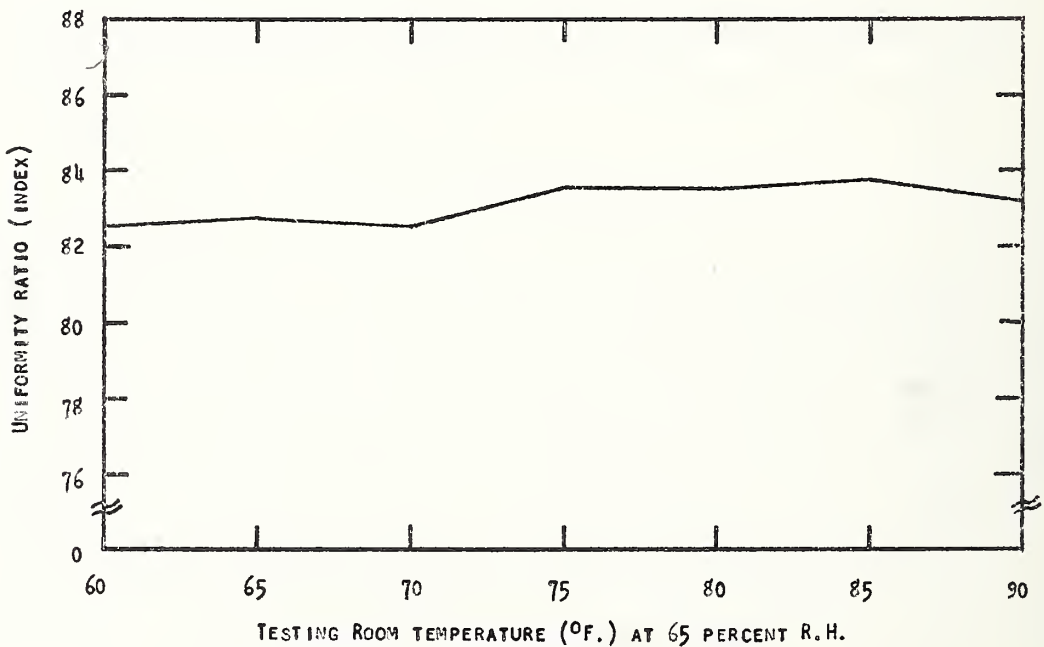


Figure 8.--Average fibrograph uniformity ratio for five cottons when tested at specified temperatures.

Table 5.--Fiber upper half mean length and length uniformity for five cottons tested under specified relative humidities at 70° F. temperature

Relative humidity $\frac{2}{\%}$	Fiber length and length uniformity ratio for specified cotton $\frac{1}{\%}$											
	Lockett 2/		Rowden 2/		Deltapine 2/		Mesilla Valley 2/		Pima 2/		Average	
Percent	Inches	Index	Inches	Index	Inches	Index	Inches	Index	Inches	Index	Inches	Index
28	0.87	80	0.96	80	1.04	76	1.25	81	1.31	75	1.086	78.4
35	.88	83	.95	81	1.03	79	1.25	79	1.31	74	1.084	79.0
45	.89	82	.97	81	1.07	79	1.29	81	1.35	77	1.114	80.0
55	.89	84	.99	82	1.07	79	1.31	82	1.38	78	1.128	81.0
<u>65</u>	<u>.90</u>	<u>84</u>	<u>1.00</u>	<u>82</u>	<u>1.09</u>	<u>81</u>	<u>1.34</u>	<u>84</u>	<u>1.38</u>	<u>79</u>	<u>1.142</u>	<u>82.0</u>
75	.92	84	1.01	83	1.12	82	1.36	85	1.41	82	1.164	83.2
85	.92	85	1.03	84	1.14	84	1.37	86	1.43	82	1.178	84.2

$\frac{1}{\%}$  Each value represents the average of five complete tests as determined by the Fibrograph instrument.

$\frac{2}{\%}$  Underlined numbers represent standard laboratory conditions.

Table 6.--Fiber fineness by Micronaire for five cottons when tested under specified temperatures at 65 percent relative humidity

Temperature 2/	Fineness (weight-per-inch) for specified cotton 1/					
	Lockett 2/	Rowden 2/	Delta- pine 2/	Mesilla valley 2/	Pima 2/	Average 2/
°F.	Micrograms per inch	Micrograms per inch	Micrograms per inch	Micrograms per inch	Micrograms per inch	Micrograms per inch
60	5.70	5.67	4.80	4.06	2.97	4.640
65	5.59	5.60	4.66	3.98	2.87	4.540
70	<u>5.62</u>	<u>5.48</u>	<u>4.59</u>	<u>3.94</u>	<u>2.89</u>	<u>4.504</u>
75	5.64	5.55	4.62	3.93	2.81	4.510
80	5.63	5.51	4.56	3.96	2.87	4.506
85	5.57	5.51	4.67	3.98	2.90	4.526
90	5.64	5.54	4.68	3.95	2.94	4.550

1/ Each value represents the average of 5 complete tests as determined by the Micronaire instrument.

2/ Underlined numbers represent standard laboratory conditions.

effect was noted when the temperature was increased from 70° to 75° F. The results for each of the five cottons indicated that the slight length increase varies with the cotton (table 8). In other words, the longer cottons are affected slightly more than the shorter cottons when tested at increased temperatures.

#### CORRECTION FACTORS REQUIRED FOR TESTING UNDER VARIOUS ATMOSPHERIC CONDITIONS

Micronaire fineness: For practical purposes, the results of this study indicated that correction factors can be applied to Micronaire values for cottons ranging from 3.5 to 5.5 micrograms-per-inch when tested at various relative humidities within a temperature range of 65° to 90° F. There was an average increase of 0.05 microgram per inch in the Micronaire value obtained for each 10-percent increase in relative humidity. This may be applied for correcting Micronaire results to standard laboratory conditions as shown in the following formula:

$$F_c = F_o + 0.005 (65 - H_o)$$

when;  $F_c$  = corrected fineness (micrograms per inch)  
 $F_o$  = observed fineness (micrograms per inch)  
 $H_o$  = observed relative humidity (percent)  
65 = standard relative humidity (percent)

For practical application, however, the formula may be reduced to the following working table of correction factors:

<u>Relative humidity</u> Percent	<u>Correction factor</u> Micrograms-per-inch
20 to 29	plus 0.20
30 to 39	plus 0.15
40 to 49	plus 0.10
50 to 59	plus 0.05
60 to 69	none
70 to 79	minus 0.05
80 to 89	minus 0.10

(Correction factors apply to cottons ranging from 3.5 to 5.5 micrograms-per-inch when tested at temperatures ranging from 65° to 90° F.)

Fibrograph length and Pressley strength: Inasmuch as standard procedures for Fibrograph and Pressley tests require that the operator obtain standard results on a standard cotton before performing tests on unknown cottons, tests performed in accordance with these procedures at various atmospheric conditions would perhaps reflect the effect of such conditions only to a limited extent. In this study, however, the standard results for the standard cottons were obtained at standard atmospheric conditions in order to reflect the effect of the various atmospheric conditions on the results obtained. The results of the study indicated that the shorter cottons by Fibrograph tests and the weaker cottons by Pressley tests are affected less by increased relative humidity than are the longer and stronger cottons. This trend was also indicated to a less extent for increased temperatures. The Fibrograph and Pressley results for this study, therefore, should not be applied in establishing correction factors for tests performed at other than standard atmospheric conditions.

Table 7.--Fiber strength for five cottons when tested under specified temperatures at 65 percent relative humidity

Temperature 2/	Fiber strength for specified cotton 1/					
	Lockett 2/	Rowden 2/	Delta- pine 2/	Mesilla valley 2/	Pima 2/	Average 2/
°F.	1,000 lb./ sq. in.	1,000 lb./ sq. in.	1,000 lb./ sq. in.	1,000 lb./ sq. in.	1,000 lb./ sq. in.	1,000 lb./ sq. in.
60	77.0	84.8	78.0	88.0	98.8	85.32
65	76.4	83.6	77.1	88.2	103.0	85.66
<u>70</u>	<u>76.7</u>	<u>83.1</u>	<u>79.0</u>	<u>88.8</u>	<u>102.0</u>	<u>85.92</u>
75	81.5	87.0	81.6	90.0	103.8	88.78
80	77.6	87.8	82.5	91.3	102.6	88.36
85	77.7	86.3	83.0	92.4	104.6	88.80
90	79.0	86.9	80.6	91.4	107.0	88.98

1/ Each value represents the average of 5 complete tests as determined by the Pressley fiber strength instrument.

2/ Underlined numbers represent standard laboratory conditions.

Table 8.--Fiber upper half mean length and length uniformity for five cottons tested under specified temperature at 65 percent relative humidity

Temperature 2/	Fiber length and length uniformity ratio for specified cottons 1/											
	Lockett 2/		Rowden 2/		Deltapine 2/		Mesilla Valley 2/		Pima 2/		Average 2/	
°F	Inches	Index	Inches	Index	Inches	Index	Inches	Index	Inches	Index	Inches	Index
60	0.89	85	0.98	85	1.07	80	1.30	84	1.36	79	1.120	82.6
65	.89	84	.98	86	1.08	80	1.31	84	1.37	80	1.126	82.8
70	.88	84	.98	84	1.08	80	1.31	83	1.36	82	1.122	82.6
75	.90	86	.99	85	1.10	82	1.33	84	1.39	81	1.142	83.6
80	.90	84	.99	84	1.09	82	1.32	85	1.38	83	1.136	83.6
85	.90	84	.99	84	1.09	83	1.31	85	1.38	83	1.134	83.8
90	.90	84	1.00	84	1.10	82	1.33	85	1.40	81	1.146	83.2

1/ Each value represents the average of five complete tests as determined by the Fibrograph instrument.

2/ Underlined numbers represent standard laboratory conditions.









